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oppressed for lack of air, and was therefore gasping for breath. As soon as I discovered the inward currents through the nostrils, I also detected an outward, rather than an inward, flow at each opening of the mouth. Further observation disclosed the enlargement of the throat as the mouth filled with water from the nostrils, the mouth opening to release the water, and the swelling of the throat subsiding as the mouth was closed. This operation was carried on for hours at a time, when the salamander would rise to the surface of the water, and, keeping its mouth shut, would for perhaps an equally long period breathe air directly into the lungs in the same manner as a frog. I had this specimen under my constant observation for nearly six months, and frequently called the attention of my students to its peculiar mode of respiration. I also had a second individual of this species in my laboratory in July, 1889, and found the operation repeated in every particular. An examination of the interior of the mouth of these salamanders revealed the presence of numerous ridges or folds of the mucous membrane in the palatal region, suggesting a probable respiratory function analogous to that of the gills of the same animals in the larval stage. The accompanying figure, from a drawing by my assistant, Mr. W. C. Stevens, represents the salamander reduced to two-thirds of its natural size.

CHARACTERISTIC SAND-HILL FLORA.

BY PROF. M. A. CARLTON, GARFIELD UNIVERSITY.

All along the principal river valleys of Kansas, especially over the broad valley of the Arkansas, numerous hillocks of sand are to be seen, which usually possess a very scanty vegetation. Many of these hills are at great distances from the present river-beds; the waters having long ago left them and receded to the present river-level. In such cases the flora is somewhat more abundant; but in all cases, wherever these hills may be found, so far as the writer's experience goes, the flora is in the main composed of the same species, although in some cases there may be a greater abundance of these species than in any others; and, indeed, a few forms may sometimes be added that are purely local.

I was first led to note these facts during the summer of 1888. In May of that year I made some collections in the vicinity of Wichita, among which were a species of plum (*Prunus chicasa*, Mx.), sometimes called the sand-plum, and the brilliant orange-flowered puccoon (*Lithospermum hirtum*, Lehm). The latter was found in a single locality on a sandy waste. Previous to this I had collected, on rocky points in Cloud county, a few specimens of a plum in flower which I did not recognize, not having yet seen the fruit. On returning to Cloud county and collecting the fruit, it proved to be the same *Prunus chicasa.* Then I remembered having seen the same species on various sand-hills along the Smoky Hill river in Saline county, and afterward I found it again in various places in Cloud county, but always in sandy wastes or on rocky points. Later on, while collecting near Miltonvale, Cloud county, I found, growing on a sand-hill, along with the previously mentioned plum, a number of fine specimens of *Lithospermum hirtum.* But, to my knowledge, this species does not grow on any other spot in that county, and I have made a pretty clean survey of the county.

These discoveries induced me to make further observations, the results of which are embodied briefly in this article. I simply present an account of each of the few species that have so far come under my consideration, in the order of their abundance and predominance as characteristic sand-hill species. Of course this is all, at most, only preliminary to further investigations on the same subject. I simply give a few facts at present. Any additions to these facts, or any definite conclusions of value that may be drawn from the facts, must be left for future papers. An intimation here of what I have further in mind in regard to this subject might however not be amiss. The idea has naturally enough suggested itself that these species may possibly bear to each other a somewhat similar relation in regard to structure, composition, and vitality, to that which they bear in regard to habitat. This is one of the questions, then, among those that may be found worthy of careful consideration. I am indebted to Prof. J. M. Coulter of Indiana and Prof. W. A. Kellerman of the Kansas Agricultural College, for aid in identifying some of the species.

SPECIES OBSERVED.

Prunus chicasa, Mx.—This is the most common sand-hill species. I have never noted its absence on any sand-hill of ordinary extent, and it sometimes grows where it seems nothing else can grow. It is found on some of the most recently formed hills, near to rivers, as well as on the older hills. Very common over a great portion of Sedgwick county, which is to a great extent bottom land, and therefore sandy. In a few places only in Cloud and Saline counties, and always on sandy wastes or rocky points.

Lithospermum hirtum, Lehm.—I have never observed this species, I think, outside of sandy districts, although I presume it has a more general distribution. Have observed and collected it in several places in Sedgwick county, and in one spot only in Cloud county.

Evolvulus argenteus, Ph.—Have collected very few specimens of this species; chiefly in Cloud county, on sandy wastes. It is reported from extreme southwest Kansas, where the country is quite sandy and somewhat barren.

Yucca angustifolia, Ph.—This species, while quite common, I think is not often found in low, moist or rich soils. I have almost invariably found it on sandy wastes, rocky hillsides, or in barren districts; and I have observed its habitat from Kansas to Montana. It is very abundant in western Kansas and eastern Colorado, which we all know to be quite a barren region. It is reported to be very abundant on the "Staked Plains" of Texas, growing, it is said, to the height of ten feet—probably a different species. The yucca soap manufacturers, of Wichita, obtain their material from the Texas yucca. In Riley county I have collected it invariably on rocky hillsides. On the extreme western plains it is associated with the sage-brush, prickly-pear, and buffalo-grass, while in the Rocky Mountains it frequents dizzy heights among the rocks just below the timber-line. It occurs along with cacti in abundance all over the southern portion of the Great Basin, and on into Mexico. All of this region is extremely barren.

Discopleura capillacea, DC.—While not limited strictly to sand-hills, this species seems to be at least characteristic of sandy districts. Have collected it on sandy wastes, in Cloud county, and in various places in Sedgwick county.

Viola tricolor, L.; *var. arvensis*, DC.—This species is extremely abundant all over the more sandy portions of Sedgwick county. Of course it is not at all limited to sandy regions, but seems only to be well adapted to such localities, and to some extent characteristic of them. It is often associated with *Prunus chicasa*, and is found on the outskirts of low woodlands and along roadsides and rising ground.

Cristatella Jamesii, Torr.—I have collected this species at Concordia, Cloud county, on sandy knolls near the Republican river, and have found it in abundance in the vicinity of Wichita, also, but always in sandy soils.

Linaria Canadensis, Spreng.—Have collected very few specimens of this species; always in sandy wastes. According to Gray's Manual, it is common in sandy soils.

I think this species has not heretofore been reported from Kansas, although it is a common species farther east. So far I have only found it in Sedgwick county.

Aplopappus divaricatus, Gr.—This species is very abundant in sandy regions, in the vicinity of Wichita, and, according to Smyth's "Catalogue of Flowering Plants and Ferns of Kansas," it is found in Barton county, a great portion of which is included in the sandy valley of the Arkansas. It is my intention to study this species still further.

Frœlichia gracilis, Moq.—The habitat of this species needs to be studied more carefully. I have collected only a few specimens, in sandy wastes near Wichita. Reported also from Cherokee, Barton and Dickinson counties. (Smyth, "Catalogue of Flowering Plants and Ferns of Kansas.")

Hosackia Purshiana, Benth.—This species seems to be characteristic of sandy districts, although quite common in other places, especially in western Kansas. Have collected it in Cloud and Sedgwick counties. It is also reported from Pawnee, Barton and Dickinson counties. (Smyth.)

The following species may yet be added to this list, also, after a better knowledge of them in regard to habitat is obtained:

Pentstemon acuminatus, Dougl.; Pyrrhopappus scaposus, DC.; Cyperus acuminatus, Torr.; Flaveria angustifolia, Pers.; Camelina sp.; Gramineæ, several species.

EXPERIMENTS FOR THE ARTIFICIAL DISSEMINATION OF A CONTAGIOUS DISEASE AMONG CHINCH-BUGS.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

At the last annual meeting of the State Board of Agriculture I presented a paper concerning the diseases of the chinch-bug. Three of these diseases were considered, and one of them was stated to have made its appearance in portions of eastern and southern Kansas in 1888. Attention was called to the investigations of Professor S. A. Forbes, the Illinois State Entomologist, and to the experiments of Dr. Otto Lugger, of the Minnesota Agricultural Experiment Station. So late as May, 1889, Professor Forbes looked upon the artificial introduction of these diseases as having no more than a theoretical basis, and Dr. Lugger in the report of his own experiments, expressed a doubt whether the fungus disease whose germs he distributed to different localities in Minnesota in 1888, did not after all reach these localities in the natural way. Being anxious if possible to settle this question and to place in the hands of our farmers a new and more efficient weapon in their warfare against their most formidable insect foe, I sought earnestly in the spring and early summer of 1889 for the first indication of the appearance of either of the three chinch-bug maladies. In these investigations I have been heartily sustained by Secretary Mohler, who has furnished all possible aid in the accomplishment of the results finally attained. The last week in June I received a letter from Dr. J. T. Curtiss, of Dwight, Morris county, conveying the gratifying intelligence that a disease had broken out among the chinch-bugs, and that the ground in many places in fields of oats and wheat was white with the dead bugs. Dr. Curtiss stated that on June 22d he saw the first sick bugs, and in a few days dead ones. From this date to June 30th, the disease destroyed the bugs in most of the fields. Where the oats or wheat were heavy, shading the ground thoroughly, *all* the bugs died. Where the crop was thin on the ground, many bugs escaped the disease. The Doctor was at once requested to forward samples of the sick and dead